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CLASS 11 | COMPUTER SCIENCE & ENTREPRENEURSHIP

CHAPTER 3

ALGORITHMS AND PROBLEM SOLVING

TOPIC-WISE STUDY GUIDE

MCQs • Notes • Examples • Diagrams • Exam Practice

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How to Use This Guide

Textbook: Punjab PECTAA Class 11, Unit 3, numbered pages 41–55 (15 pages). Topic headings and exercise sections follow the uploaded chapter. All 80 additional MCQs are ORIGINAL board-style practice; they are not attributed to a past paper.

2027 Smart Syllabus: Section 3.3.3 (P, NP, NP-hard, NP-complete), textbook exercise MCQs 2–4 and long question 1 are excluded from the 2027 Punjab Board examination. For learning they are described briefly where relevant but not targeted for 2027 exam practice. Source: PECTAA Grade 11 ALP notification (Nov 2026).

2027 pairing: Chapter 3 contributes 1 MCQ to Q1 and 3 short questions to Q3 in the full board examination. This guide's chapter-only test is additional practice, not the official paper pattern.

1. Chapter Overview and Topic Priority

Textbook topic	Study priority (estimated)	Past-paper evidence
3.1 Computational Problems	⭐⭐	Original practice; no verified board/year assignment
3.2 Generate-and-Test Method	⭐⭐	Original practice; no verified board/year assignment
3.3 Solvability and Tractability	⭐⭐	Original practice; no verified board/year assignment
3.4 Algorithm Analysis	⭐⭐⭐	Original practice; no verified board/year assignment
3.5 Algorithm Design Techniques	⭐⭐	Original practice; no verified board/year assignment
3.6 Sorting Algorithms	⭐⭐⭐	Original practice; no verified board/year assignment
3.6 Searching Algorithms	⭐⭐⭐	Original practice; no verified board/year assignment
3.6 Graph Traversal (BFS and DFS)	⭐⭐⭐	Original practice; no verified board/year assignment

2. Topic-Wise Important MCQs with Highlighted Answers

3.1 Computational Problems

Q1. What is the input of a computational problem?

A) Data provided to an algorithm ✓

B) Only a flowchart

C) A programming error

D) The final answer

Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: Input is the information the algorithm receives.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

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Q2. What is the output of an algorithm?

A) The original data

B) A syntax rule

C) Its produced result ✓

D) The processor speed

Correct Answer: C | Importance: ★★ | Status: Original board-style practice

Explanation: Output is the answer after processing.

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Q3. A problem asking whether a number is even is a:

A) Sorting problem

B) Decision problem ✓

C) Counting problem

D) Optimization problem

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

Explanation: It requires a yes/no decision.

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Q4. Finding the shortest route between two cities is an example of:

A) Syntax checking

B) Counting problem

C) File copying

D) Optimization problem ✓

Correct Answer: D | Importance: ★★ | Status: Original board-style practice

Explanation: Optimization seeks the best solution against a criterion.

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Q5. Counting how many passwords meet a condition is a:

A) Optimization problem

B) Counting problem ✓

C) Decision problem

D) Compilation task

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

Explanation: A counting problem asks for the number of valid solutions.

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Q6. Which feature is essential to a well-defined problem?

A) Missing constraints

B) Clearly specified inputs and goals ✓

C) Unknown outputs

D) Ambiguous goals

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

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Explanation: A well-defined problem has precise objectives and inputs.

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Q7. Why is the instruction "make a good drawing" ill-defined?

A) Its success criteria are ambiguous ✓

B) It has a known output

C) It specifies all constraints

D) It uses numeric input

Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: Good is subjective unless measurable criteria are given.

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Q8. The computational processing stage mainly consists of:

A) Only the user name

B) The keyboard layout

C) The final output alone

D) A sequence of steps or rules ✓

Correct Answer: D | Importance: ★★ | Status: Original board-style practice

Explanation: Processing applies the algorithm to input.

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Q9. Which problem asks for a yes/no answer?

A) Optimization

B) Enumeration only

C) Counting

D) Decision ✓

Correct Answer: D | Importance: ★★ | Status: Original board-style practice

Explanation: Decision problems have binary outcomes.

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Q10. Which best illustrates a well-defined problem?

A) Check whether integer n is divisible by 2 ✓

B) Make everything fast

C) Find something interesting

D) Design a beautiful thing

Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: Divisibility is a precise test.

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3.2 Generate-and-Test Method

Q11. Generate-and-test first produces:

A) A sorted database

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B) Final verified answers

C) Candidate solutions ✓

D) Only machine code

Correct Answer: C | Importance: ★★ | Status: Original board-style practice

Explanation: The generator proposes candidates.

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Q12. The tester in generate-and-test:

A) Writes all possible questions

B) Changes a CPU

C) Checks whether a candidate meets conditions ✓

D) Creates a computer network

Correct Answer: C | Importance: ★★ | Status: Original board-style practice

Explanation: The tester evaluates the candidate.

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Q13. What happens when a generated candidate is invalid?

A) Delete all inputs

B) Assume it is correct

C) Always stop successfully

D) Try another candidate ✓

Correct Answer: D | Importance: ★★ | Status: Original board-style practice

Explanation: An unsuccessful candidate leads to another attempt.

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Q14. Generate-and-test may be inefficient because:

A) It always finds an optimal answer first

B) It can examine many possibilities ✓

C) It requires no input

D) It never evaluates results

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

Explanation: Exhaustive search can require many trials.

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Q15. Which application is well suited to generate-and-test?

A) Trying puzzle arrangements ✓

B) Renaming a folder

C) Formatting a heading

D) Changing screen brightness

Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: Puzzle solutions can be proposed and checked.

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Q16. A heuristic can improve generate-and-test by:

A) Removing test conditions

B) Making each candidate correct

C) Guaranteeing zero computation

D) Reducing the candidates to explore ✓

Correct Answer: D | Importance: ★★ | Status: Original board-style practice

Explanation: Heuristics prioritize promising candidates.

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Q17. A candidate is accepted when it:

A) Satisfies the required test ✓

B) Appears first

C) Uses the most memory

D) Contains the most characters

Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: Acceptance depends on requirements.

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Q18. An exhaustive generate-and-test strategy explores:

A) All relevant candidates until resolved ✓

B) No candidates

C) Only the smallest number

D) Only the first possibility

Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: Exhaustive means systematically testing possible candidates.

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Q19. The sequence of generate-and-test is:

A) Sort → Encrypt → Exit

B) Generate → Test → Repeat if needed ✓

C) Compile → Print → Delete

D) Test → Stop → Input

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

Explanation: The testing loop follows candidate generation.

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Q20. A major limitation of exhaustive search is:

A) Lack of a test step

B) Large search spaces ✓

C) Only numeric inputs

D) Requirement for sorted arrays

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

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Explanation: Many possibilities may be computationally costly.

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3.3 Solvability and Tractability

Q21. A solvable computational problem has:

A) An infinite alphabet

B) No possible solution procedure

C) Only graphical input

D) An algorithm that produces a solution ✓

Correct Answer: D | Importance: ★★ | Status: Original board-style practice

Explanation: Solvability means an algorithm exists.

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Q22. The halting problem is a famous example of an:

A) Unsolvable problem ✓

B) Optimization heuristic

C) Linear search

D) Sorting algorithm

Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: No general algorithm can decide halting for every program-input pair.

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Q23. A tractable problem can generally be solved in:

A) No defined amount of time

B) Polynomial time ✓

C) Constant memory always

D) Infinite time only

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

Explanation: Tractable commonly means efficiently solvable as input grows.

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Q24. Which time bound is polynomial?

A) $O(3^n)$

B) $O(n!)$

C) $O(2^n)$

D) $O(n^2)$ ✓

Correct Answer: D | Importance: ★★ | Status: Original board-style practice

Explanation: n squared is polynomial.

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Q25. Which time bound grows exponentially?

A) $O(n)$

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B) $O(2^n)$ ✓

C) $O(n^2)$

D) O(log n)

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

Explanation: Two to the n grows exponentially.

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Q26. Why do intractable problems become impractical?

A) Their resource needs rise rapidly with input size ✓

B) Their input is always empty

C) They cannot be written in English

D) They never use arithmetic

Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: Very fast growth may make large instances infeasible.

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Q27. What is the Traveling Salesman Problem seeking?

A) The fastest CPU brand

B) A shortest tour visiting cities and returning ✓

C) A list of book titles

D) The largest integer

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

Explanation: TSP asks for a minimum-cost visiting tour.

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Q28. Before selecting a solving algorithm, we should check:

A) How many icons are installed

B) Whether the file name is short

C) The color of the keyboard

D) Whether the problem is solvable and practical ✓

Correct Answer: D | Importance: ★★ | Status: Original board-style practice

Explanation: Feasibility and resources should be evaluated.

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Q29. Which generally scales better for large n?

A) O(n!) than O(n)

B) All growth rates are equal

C) $O(n^2)$ than $O(2^n)$ ✓

D) $O(2^n)$ than $O(n^2)$

Correct Answer: C | Importance: ★★ | Status: Original board-style practice

Explanation: Polynomial growth is generally more manageable than exponential.

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Q30. What does a computationally unsolvable problem lack?

A) Any input

B) A name

C) An algorithm correct for every relevant instance ✓

D) Any examples

Correct Answer: C | Importance: ★★ | Status: Original board-style practice

Explanation: Unsolvability means no general algorithm can solve all cases.

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3.4 Algorithm Analysis

Q31. Time complexity describes:

A) The color of source code

B) The number of files

C) Physical clock type

D) How runtime grows with input size ✓

Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

Explanation: It studies growth in work or execution time.

اردو وضاحت: Time complexity اِن پٹ کے بڑھنے پر وقت کے اضافے کو بیان کرتی ہے۔

Q32. Space complexity measures:

A) Memory requirements as input size changes ✓

B) Internet speed

C) Output screen size

D) Time zone

Correct Answer: A | Importance: ★★★ | Status: Original board-style practice

Explanation: Space complexity models memory use.

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Q33. Big O notation is commonly used to describe:

A) A variable name

B) An IDE

C) A file format

D) An asymptotic upper bound ✓

Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

Explanation: Big O provides an upper bound on growth.

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Q34. Which complexity is constant?

A) O(1) ✓

B) $O(2^n)$

C) O(n)

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D) $O(n^2)$

Correct Answer: A | Importance: ★★★ | Status: Original board-style practice

Explanation: O(1) does not grow with input size.

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Q35. Which complexity is linear?

A) O(1)

B) O(log n)

C) $O(n^2)$

D) O(n) ✓

Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

Explanation: O(n) grows proportionally with input length.

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Q36. Which complexity commonly describes halving the search interval?

A) $O(2^n)$

B) O(log n) ✓

C) $O(n^2)$

D) O(n!)

Correct Answer: B | Importance: ★★★ | Status: Original board-style practice

Explanation: Repeated halving is logarithmic.

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Q37. Two nested loops each running n times often produce:

A) $O(n^2)$ ✓

B) O(log n)

C) O(1)

D) $O(n^3)$ always

Correct Answer: A | Importance: ★★★ | Status: Original board-style practice

Explanation: n times n is quadratic.

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Q38. Which is typically fastest-growing?

A) O(log n)

B) O(1)

C) $O(n^2)$ ✓

D) O(n)

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: Quadratic grows faster than listed alternatives for large n.

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Q39. For large datasets, efficiency is judged mainly by:

A) Growth in resource consumption ✓

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B) Monitor model

C) Desktop wallpaper

D) Text font size

Correct Answer: A | Importance: ★★★ | Status: Original board-style practice

Explanation: Asymptotic trends help compare algorithms.

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Q40. Why may O(log n) be preferable to O(n)?

A) It grows more slowly as input increases ✓

B) It requires no comparisons

C) It works on every problem

D) It always consumes no memory

Correct Answer: A | Importance: ★★★ | Status: Original board-style practice

Explanation: Logarithmic growth is slower than linear growth.

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3.5 Algorithm Design Techniques

Q41. Divide-and-conquer works by:

A) Splitting a problem into smaller subproblems ✓

B) Using only one variable

C) Removing all constraints

D) Trying only random answers

Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: It solves smaller parts then combines results.

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Q42. Merge sort exemplifies:

A) Divide-and-conquer ✓

B) Trial-and-error only

C) Linear search

D) Greedy choice only

Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: Merge sort divides, sorts, and merges.

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Q43. A greedy algorithm makes:

A) A locally best choice at each step ✓

B) Only random decisions

C) Every future choice simultaneously

D) No decisions

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Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: Greedy methods select locally attractive options.

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Q44. A greedy strategy is guaranteed globally optimal:

A) Whenever code is short

B) Only for suitable problems with required properties ✓

C) For every possible problem

D) When no data is provided

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

Explanation: Greedy choices do not always yield a global optimum.

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Q45. Dynamic programming helps when subproblems:

A) Cannot be identified

B) Never repeat

C) Overlap and can reuse stored results ✓

D) Have no outputs

Correct Answer: C | Importance: ★★ | Status: Original board-style practice

Explanation: DP stores and reuses solutions to overlapping subproblems.

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Q46. The Fibonacci sequence is often used to demonstrate:

A) Binary search on text

B) Network routing only

C) Dynamic programming ✓

D) Machine translation

Correct Answer: C | Importance: ★★ | Status: Original board-style practice

Explanation: Memoization avoids repeated Fibonacci work.

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Q47. Backtracking involves:

A) Undoing an unsuccessful partial choice ✓

B) Always keeping each choice

C) No checking

D) Only sorting numbers

Correct Answer: A | Importance: ★★ | Status: Original board-style practice

Explanation: It explores alternatives after dead ends.

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Q48. Maze solving can illustrate:

A) Only interpolation

B) Backtracking ✓

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C) Encryption

D) Compiling

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

Explanation: Dead-end routes can be undone.

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Q49. Which method uses a split-solve-combine structure?

A) Code formatting

B) Linear search

C) Divide-and-conquer ✓

D) Selection sort alone

Correct Answer: C | Importance: ★★ | Status: Original board-style practice

Explanation: The parts are solved then combined.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q50. Which technique is especially useful for overlapping subproblems?

A) Bubble swapping

B) Dynamic programming ✓

C) Always greedy

D) Brute-force without caching

Correct Answer: B | Importance: ★★ | Status: Original board-style practice

Explanation: DP avoids recalculating the same cases.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

3.6 Sorting Algorithms

Q51. Bubble sort compares:

A) Adjacent items ✓

B) Only first and last items

C) Graph vertices only

D) Random file names

Correct Answer: A | Importance: ★★★ | Status: Original board-style practice

Explanation: Bubble sort compares neighbors and swaps if needed.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q52. Bubble sort worst-case complexity is:

A) O(1)

B) O(n log log n)

C) O(log n)

D) $O(n^2)$ ✓

Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

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Explanation: Repeated passes generate quadratic work.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q53. Selection sort repeatedly selects:

A) The smallest remaining element for ascending order ✓

B) A random graph node

C) The average of all values

D) The last line of code

Correct Answer: A | Importance: ★★★ | Status: Original board-style practice

Explanation: It places the minimum of the remaining portion next.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q54. Selection sort worst-case time is:

A) O(log n)

B) $O(2^n)$

C) O(1)

D) $O(n^2)$ ✓

Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

Explanation: Finding a minimum repeatedly is quadratic.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q55. What is the goal of sorting?

A) Remove every duplicate necessarily

B) Compress the data always

C) Arrange items in a specified order ✓

D) Translate Python into Java

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: Sorting orders elements by a key.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q56. After one ordinary bubble-sort pass, the largest item generally:

A) Changes value

B) Disappears

C) Moves to the middle always

D) Moves to the end ✓

Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

Explanation: Successive adjacent swaps push the maximum rightward.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q57. Which sort repeatedly searches the unsorted region for a minimum?

A) BFS

B) Bubble sort

C) Selection sort ✓

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D) Binary search

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: Selection sort finds and places the minimum.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q58. Which list is ascending?

A) [8, 2, 11, 5]

B) [2, 11, 5, 8]

C) [2, 5, 8, 11] ✓

D) [11, 8, 5, 2]

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: Ascending order increases from left to right.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q59. Which algorithm is generally less suitable for large datasets?

A) Merge sort

B) Bubble sort ✓

C) Efficient divide-and-conquer sort

D) O(n log n) sort

Correct Answer: B | Importance: ★★★ | Status: Original board-style practice

Explanation: Quadratic sorting becomes costly on large inputs.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q60. Sorting is often useful before applying:

A) Linear search exclusively

B) BFS exclusively

C) Binary search ✓

D) DFS exclusively

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: Binary search requires sorted data.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

3.6 Searching Algorithms

Q61. Linear search examines elements:

A) Only at the middle

B) One by one ✓

C) Only after sorting

D) By using a queue of nodes

Correct Answer: B | Importance: ★★★ | Status: Original board-style practice

Explanation: Linear search checks items sequentially.

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اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q62. Linear search works on:

A) Only graph edges

B) Only binary trees

C) Only sorted lists

D) Sorted or unsorted lists ✓

Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

Explanation: It does not require sorted input.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q63. Linear search worst-case time is:

A) O(1)

B) O(n) ✓

C) O(log n)

D) $O(n^2)$

Correct Answer: B | Importance: ★★★ | Status: Original board-style practice

Explanation: It may inspect all n elements.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q64. Binary search requires the input to be:

A) Encrypted

B) A graph

C) Sorted ✓

D) Randomly shuffled

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: Correct binary search needs ordered data.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q65. Binary search initially inspects the:

A) Largest value always

B) Last element only

C) First element only

D) Middle element ✓

Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

Explanation: The midpoint divides the search interval.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q66. Binary search worst-case time is:

A) $O(n^2)$

B) O(n!)

C) O(n)

D) O(log n) ✓

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Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

Explanation: The remaining interval is halved each step.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q67. If a binary-search target is smaller than the midpoint, continue:

A) At the same position forever

B) Outside the list

C) In the right half

D) In the left half ✓

Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

Explanation: Sorted ordering excludes the larger half.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q68. If a binary-search target is larger than the midpoint, continue:

A) With every element

B) At the first element always

C) In the right half ✓

D) In the left half

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: The smaller half can be eliminated.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q69. Which method is simpler for a small unsorted list?

A) Binary search without sorting

B) Merge sort alone

C) Linear search ✓

D) Graph traversal only

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: Linear search works directly on unsorted data.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q70. For a large sorted list, the more efficient search is generally:

A) Linear search

B) Selection sort

C) Binary search ✓

D) Bubble sort

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: Logarithmic binary search scales better.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

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3.6 Graph Traversal (BFS and DFS)

Q71. Breadth-first search typically uses a:

A) Compiler

B) Priority sorting

C) Queue ✓

D) Stack only

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: BFS processes discovered vertices FIFO.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q72. Depth-first search typically uses a:

A) Stack or recursion ✓

B) Hashing only

C) Queue exclusively

D) Spreadsheet

Correct Answer: A | Importance: ★★★ | Status: Original board-style practice

Explanation: DFS explores deeply using stack behavior.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q73. BFS explores a graph:

A) By sorting keys first

B) Level by level ✓

C) In descending value order

D) Only one edge

Correct Answer: B | Importance: ★★★ | Status: Original board-style practice

Explanation: BFS visits nearby levels first.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q74. DFS explores:

A) Only weighted edges

B) Every level completely before descending

C) Only disconnected components

D) A path deeply before backtracking ✓

Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

Explanation: DFS follows one branch before returning.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q75. BFS can find shortest paths in an:

A) Any negative-weight graph automatically

B) Unsorted array only

C) Unweighted graph ✓

D) Arbitrary weighted graph without adaptation

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Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: BFS minimizes number of edges in unweighted graphs.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q76. For a maze, exploring one route to a dead end resembles:

A) DFS ✓

B) Selection sort

C) Binary search

D) Bubble sort

Correct Answer: A | Importance: ★★★ | Status: Original board-style practice

Explanation: DFS can follow and backtrack from routes.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q77. A graph consists of:

A) Vertices and edges ✓

B) Rows and columns only

C) Only numbers

D) Only loops

Correct Answer: A | Importance: ★★★ | Status: Original board-style practice

Explanation: Vertices are nodes and edges connect them.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q78. A queue follows:

A) Last in, first out

B) Random deletion

C) First in, first out ✓

D) Largest first necessarily

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: FIFO is queue order.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q79. A stack follows:

A) First in, first out

B) Smallest first always

C) Sorted order

D) Last in, first out ✓

Correct Answer: D | Importance: ★★★ | Status: Original board-style practice

Explanation: LIFO describes stack operations.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

Q80. Typical BFS and DFS time on adjacency-list graphs is:

A) O(V × E) always

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B) $O(2^E)$ always

C) O(V + E) ✓

D) O(1) for any graph

Correct Answer: C | Importance: ★★★ | Status: Original board-style practice

Explanation: Each vertex and edge can be processed in linear total work.

اردو وضاحت: درست جواب متعلقہ تعریف یا الگورتھم کے بنیادی اصول کو ظاہر کرتا ہے۔

3. Easy Topic-Wise Notes, Examples and Revision

3.1 Understanding Computational Problems

A computational problem is a task that can be expressed through inputs, processing rules, and expected outputs. A clear problem statement guides algorithm design.

Key Concepts

Input → Process → Output. Decision questions have yes/no answers; search finds an item; optimization seeks the best possible solution; counting determines how many solutions exist. Well-defined problems specify goals, inputs, outputs and constraints.

Worked / Real-Life Examples

Example 1: Given integer 14, check whether 14 % 2 == 0; output Even. Example 2: Given routes of lengths 5, 8 and 3 km, choose 3 km.

Common Mistake

Do not mistake an ambiguous goal like “create a nice picture” for a measurable algorithmic specification.

Quick Revision

Decision, search, counting, optimization; exact inputs, outputs and constraints.

3.2 Algorithms for Problem Solving

An algorithm is a finite sequence of instructions used to solve a problem. Generate-and-test is one introductory method.

Key Concepts

Generate a candidate; test it against the conditions; stop if correct; otherwise generate another. A heuristic can reduce the number of candidates, but does not automatically guarantee correctness or optimality.

Worked / Real-Life Examples

Example 1: Try combinations for a lock and test each. Example 2: Try possible puzzle arrangements and check all rules.

Common Mistake

A generated candidate is not necessarily a verified solution.

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Quick Revision

Generator, tester, repeat-until-valid, exhaustive search, heuristic.

3.3 Problem Solvability and Complexity

Before implementing a solution, determine whether the problem is algorithmically solvable and whether it can be computed with realistic resources.

Key Concepts

Solvable means an algorithm can produce a correct solution for all required instances. Unsolvable means no such general algorithm exists. Tractable problems are commonly associated with polynomial-time solutions. Exponential growth may become impractical.

Worked / Real-Life Examples

Example 1: Greatest Common Divisor is solvable by Euclid's algorithm. Example 2: The general halting problem is undecidable.

Common Mistake

Do not confuse unsolvable with merely slow.

Quick Revision

Solvable vs unsolvable; tractable vs intractable; polynomial vs exponential.

3.4 Algorithm Analysis

Algorithm analysis estimates how computational resources grow as inputs increase. Big O describes an asymptotic upper bound.

Key Concepts

O(1) constant; O(log n) logarithmic; O(n) linear; $O(n^2)$ quadratic. Time complexity measures work or runtime growth. Space complexity measures memory growth. Ignore lower-order terms when reporting common asymptotic bounds.

Worked / Real-Life Examples

Example 1: Checking a known array position is O(1). Example 2: Visiting n entries once is O(n).

Common Mistake

Big O is not an exact running time in seconds.

Quick Revision

Time vs space, asymptotic growth, Big O notation.

3.5 Algorithm Design Techniques

Algorithm design techniques are reusable approaches for building efficient solutions. Different problems favor different strategies.

Key Concepts

Divide-and-conquer splits and combines subproblems; greedy selects locally attractive steps; dynamic programming saves answers for overlapping subproblems; backtracking reverses partial choices that fail.

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Worked / Real-Life Examples

Example 1: Merge sort divides lists and merges sorted halves. Example 2: Memoized Fibonacci avoids duplicate calculations. Example 3: A maze solver backtracks from blocked passages.

Common Mistake

Greedy does not always yield a globally optimal answer.

Quick Revision

Divide-and-conquer, greedy, dynamic programming, backtracking.

3.6.1 Sorting Algorithms

Sorting arranges data in ascending or descending order. Bubble sort and selection sort are two introductory comparison-based methods.

Key Concepts

Bubble sort compares adjacent items and swaps them if in the wrong order; repeatedly move across the list. Selection sort finds the minimum in the unsorted region and moves it to the next output position. Both are $O(n^2)$ in the worst case.

Worked / Real-Life Examples

Example: Sort [5, 3, 8, 4]. Bubble first pass: [3, 5, 4, 8], eventually [3, 4, 5, 8]. Selection first pass places 3 first.

Common Mistake

Selection sort does not swap every adjacent pair; that is bubble sort.

Quick Revision

Ascending/descending; comparison, swap, passes; $O(n^2)$.

3.6.2 Searching Algorithms

Searching locates a specified value in a collection. Linear search and binary search are standard introductory methods.

Key Concepts

Linear search checks items sequentially, O(n) worst case, and needs no sorting. Binary search compares the middle element and keeps only the relevant half, O(log n) worst case, but requires sorted input.

Worked / Real-Life Examples

Example 1: Linear search finds 9 in [4, 9, 2] by checking 4 then 9. Example 2: Binary search for 7 in [1, 3, 5, 7, 9] starts at 5 then checks the right half.

Common Mistake

Binary search on an unsorted list can produce incorrect results.

Quick Revision

Linear O(n) vs binary O(log n); sorted precondition.

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3.6.3 Graph Algorithms

A graph consists of vertices (nodes) and edges (connections). Graph traversal systematically explores reachable vertices.

Key Concepts

Breadth-first search (BFS) explores nodes level by level with a queue. Depth-first search (DFS) explores one branch deeply using a stack or recursion. Both are O(V+E) for adjacency-list graph representation. BFS finds minimum-edge paths in unweighted graphs.

Worked / Real-Life Examples

Example 1: BFS finds degrees of separation in a friendship network. Example 2: DFS explores a maze and backtracks from dead ends.

Common Mistake

BFS uses FIFO queue; DFS uses LIFO stack/recursion.

Quick Revision

Graph, vertices, edges, BFS, DFS, queue, stack.

4. Graphics and Concept Diagrams

Input–Process–Output

INPUT	ALGORITHM / PROCESS	OUTPUT

Example: integer 8 → check divisibility by 2 → Even

Generate-and-Test Loop

GENERATE CANDIDATE	TEST CONDITIONS	ACCEPT OR TRY AGAIN

Invalid candidates loop back to generation.

Binary Search

SORTED LIST	CHECK MIDDLE	KEEP RELEVANT HALF	REPEAT

Each comparison reduces the interval by approximately half.

BFS versus DFS

BFS: QUEUE / LEVELS	DFS: STACK / DEPTH

BFS visits layer by layer; DFS follows a path before backtracking.

5. Important Comparisons

Concept A	Concept B	Exam distinction
Well-defined	Ill-defined	Precise, measurable goals vs unclear/ambiguous expectations
Tractable	Intractable	Manageable computation vs impractically rapid growth
Time complexity	Space complexity	Execution work vs memory growth

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Bubble sort	Selection sort	Swap adjacent items vs select minimum remaining
Linear search	Binary search	Sequential on any list vs repeated halving on sorted list
BFS	DFS	Queue and level order vs stack/recursion and depth

6. Important Short Questions with Model Answers

Q1. Differentiate well-defined and ill-defined computational problems.

Answer: Well-defined problems have specific inputs, goals, constraints and outputs. Ill-defined problems have vague or subjective requirements.

Q2. What is the generate-and-test method?

Answer: It generates candidate solutions and tests each against conditions until a valid solution is found or candidates are exhausted.

Q3. Differentiate tractable and intractable problems.

Answer: Tractable problems commonly have efficient polynomial-time algorithms; intractable problems may need impractical resources for large instances.

Q4. What is Big O notation?

Answer: It is asymptotic notation used to express an upper bound on the growth of an algorithm's time or space requirement.

Q5. Define time complexity.

Answer: Time complexity estimates how computational work grows as input size increases.

Q6. Define space complexity.

Answer: Space complexity estimates the amount of memory used as input size changes.

Q7. Explain the idea of greedy algorithms.

Answer: A greedy algorithm chooses a locally best option at each step, aiming for a good or optimal overall result when suitable.

Q8. How does dynamic programming avoid repeated work?

Answer: It stores solutions to overlapping subproblems so that they can be reused.

Q9. What is the basic principle of bubble sort?

Answer: Compare adjacent items and swap them when out of order; repeat passes until sorted.

Q10. Define selection sort.

Answer: Repeatedly choose the smallest unsorted item and place it into the next sorted position.

Q11. Differentiate linear search and binary search.

Answer: Linear search checks items sequentially without requiring sorting; binary search halves the search range on sorted input.

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Q12. What is BFS?

Answer: Breadth-first search explores a graph level by level using a queue.

Q13. What is DFS?

Answer: Depth-first search follows a branch as deeply as possible using a stack or recursion, then backtracks.

Q14. Why does binary search need a sorted list?

Answer: The algorithm discards half its candidates based on whether the target is less or greater than the middle value.

Q15. Why are divide-and-conquer algorithms useful?

Answer: They simplify a large problem by solving smaller independent parts and combining the results.

Q16. What factors help evaluate algorithm efficiency?

Answer: Time complexity, space complexity, scalability, input size and implementation constraints.

7. Important Long Questions with Model Answers

Long Q1. Discuss linear search and binary search with comparison.

Linear search checks each value sequentially, stopping if it matches the target. It works on unsorted inputs and has O(n) worst-case time. Binary search requires sorted data, checks the middle value, and repeatedly discards the irrelevant half. It has O(log n) worst-case time. Example: searching 7 in [1,3,5,7,9] checks middle 5 then the right segment. Binary search is more efficient for large sorted datasets.

Long Q2. Explain bubble sort with an example and complexity.

Bubble sort compares adjacent entries and swaps out-of-order neighbors. On [5,3,8,4], the first pass yields [3,5,4,8] and subsequent passes yield [3,4,5,8]. It is easy to understand but has $O(n^2)$ worst-case time, so it is inefficient on large inputs.

Long Q3. Describe major algorithm design techniques.

Divide-and-conquer splits problems, solves components and combines them (merge sort). Greedy repeatedly chooses locally promising actions (some coin-change systems). Dynamic programming stores solutions to overlapping subproblems (Fibonacci). Backtracking explores candidate choices and undoes unsuccessful paths (maze solving). The best method depends on problem structure.

Long Q4. Explain BFS and DFS with applications and complexity.

BFS processes vertices level by level via a queue and can find shortest edge-count paths in unweighted graphs. DFS uses a stack or recursion to explore branches deeply before backtracking. In adjacency-list representations, both usually run in O(V+E) time. BFS is useful for friendship degrees; DFS is useful for maze traversal.

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Long Q5. Explain algorithm time and space complexity and common Big O classes.

Time complexity models running work as input grows; space complexity models memory use. O(1) denotes constant growth, O(log n) logarithmic growth, O(n) linear, and $O(n^2)$ quadratic. These help assess scalability. For example, scanning a list is O(n) while binary searching a sorted list is O(log n).

8. Past Paper and Expected Questions

Verified board/year MCQ records: none established from the supplied textbook or independently authenticated past-paper originals. Textbook exercise is not itself proof of appearance in a board examination. The newly written questions in this guide are labeled original board-style practice.

2027 syllabus verified externally: section 3.3.3, textbook exercise MCQs 2–4 and long question 1 are excluded. These are not presented as 2027 priority questions.

9. Quick Revision Checklist

- Understand input, process and output.
- Identify decision, counting, search and optimization problems.
- Explain generate-and-test.
- Distinguish solvability from efficiency.
- Know O(1), O(log n), O(n), $O(n^2)$.
- Compare divide-and-conquer, greedy, DP and backtracking.
- Trace bubble and selection sorts.
- Use linear search and binary search appropriately.
- Compare BFS queue and DFS stack.
- Review source textbook exercise pages 54–55; observe ALP exclusions.

10. Chapter Practice Test — Student Copy

20 MCQs (no highlighted answers); 10 short questions; 3 long questions. This chapter-level practice is not the full Punjab Board paper pattern.

1. What is the input of a computational problem?

A) Data provided to an algorithm B) Only a flowchart C) A programming error D) The final answer

2. What is the output of an algorithm?

A) The original data B) A syntax rule C) Its produced result D) The processor speed

3. A problem asking whether a number is even is a:

A) Sorting problem B) Decision problem C) Counting problem D) Optimization problem

4. Counting how many passwords meet a condition is a:

A) Optimization problem B) Counting problem C) Decision problem D) Compilation task

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5. Which feature is essential to a well-defined problem?

A) Missing constraints B) Clearly specified inputs and goals C) Unknown outputs D) Ambiguous goals

6. Generate-and-test first produces:

A) A sorted database B) Final verified answers C) Candidate solutions D) Only machine code

7. What happens when a generated candidate is invalid?

A) Delete all inputs B) Assume it is correct C) Always stop successfully D) Try another candidate

8. Which application is well suited to generate-and-test?

A) Trying puzzle arrangements B) Renaming a folder C) Formatting a heading D) Changing screen brightness

9. A solvable computational problem has:

A) An infinite alphabet B) No possible solution procedure C) Only graphical input D) An algorithm that produces a solution

10. Which time bound is polynomial?

A) $O(3^n)$ B) $O(n!)$ C) $O(2^n)$ D) $O(n^2)$

11. Time complexity describes:

A) The color of source code B) The number of files C) Physical clock type D) How runtime grows with input size

12. Big O notation is commonly used to describe:

A) A variable name B) An IDE C) A file format D) An asymptotic upper bound

13. Which complexity is linear?

A) $O(1)$ B) $O(\log n)$ C) $O(n^2)$ D) $O(n)$

14. Merge sort exemplifies:

A) Divide-and-conquer B) Trial-and-error only C) Linear search D) Greedy choice only

15. A greedy strategy is guaranteed globally optimal:

A) Whenever code is short B) Only for suitable problems with required properties C) For every possible problem D) When no data is provided

16. Bubble sort worst-case complexity is:

A) $O(1)$ B) $O(n \log \log n)$ C) $O(\log n)$ D) $O(n^2)$

17. Which sort repeatedly searches the unsorted region for a minimum?

A) BFS B) Bubble sort C) Selection sort D) Binary search

18. Linear search works on:

A) Only graph edges B) Only binary trees C) Only sorted lists D) Sorted or unsorted lists

19. BFS explores a graph:

A) By sorting keys first B) Level by level C) In descending value order D) Only one edge

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20. A stack follows:

A) First in, first out B) Smallest first always C) Sorted order D) Last in, first out

Practice Short Questions

1. Differentiate well-defined and ill-defined computational problems.
2. What is the generate-and-test method?
3. Differentiate tractable and intractable problems.
4. What is Big O notation?
5. Define time complexity.
6. Define space complexity.
7. Explain the idea of greedy algorithms.
8. How does dynamic programming avoid repeated work?
9. What is the basic principle of bubble sort?
10. Define selection sort.

Practice Long Questions

1. Discuss linear search and binary search with comparison.
2. Explain bubble sort with an example and complexity.
3. Describe major algorithm design techniques.

11. Practice Test Answer Key

MCQ Key: 1-A, 2-C, 3-B, 4-B, 5-B, 6-C, 7-D, 8-A, 9-D, 10-D, 11-D, 12-D, 13-D, 14-A, 15-B, 16-D, 17-C, 18-D, 19-B, 20-D

Short questions: use model answers in Section 6. Long questions: use model answers in Section 7.

12. Sources and Status

Primary source: uploaded “11th Class Computer Science Punjab Board Book Chapter 3.pdf”, Unit 3, numbered pages 41–55. Chapter sections 3.1–3.6 and exercise questions on pages 54–55.

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